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COLOUR BLIND FEMALES:

The Inheritance of Colour Blindness in Man

BY

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MEDICAL literature has so far but rarely touched upon colour blindness in females; it is true, that the subject is practically of little interest, but theoretically the occurrence of red-green blindness as an hereditary character is of great importance.

Since the extensive statistics of 1870-1880 little research work has been published concerning the colour sense of women, and I have found very few papers on the subject undertaken with the superior clinical tests of colour sense, which we command at the present time. Since the spring of 1918 I have therefore undertaken a series of such investigations on schoolgirls, having been guided in my choice of tests by the results previously obtained in my investigations on the same subject, carried out in March, 1918. The following six tests have been used: Stilling, Podestà, Nagel, Cohn, Holmgren, Daae.* The tests showed, that out of 332 recruits 37, i.e., 11.2 per cent. were dichromatics or anomalous trichromatics, as seen from the following table.**

Stilling,	Podestà	Nagel	Cohn	Holmgren	Daae
37—	37—	31—	27—	20—	16
		4 df.	4 df.	5 df.	4 df.
		2 +	6 +	12 +	17 +

* Stilling, 14th edition, 1914. Podestà, 1st edition, 1916. Nagel, 7th edition, 1911. Cohn, 5th edition, 1914. Holmgren's coloured wool skeins with skeins 5 cm. long. Daae's original table of 1877.

** — not passed, df. = doubtful, + = passed.

The figures are in accord with those found by others, e.g., E. Franke, and with impressions gained by clinical examinations on colour sense. The colour sense was tested in 4 schools, the investigation including 1,270 girls at the age of 10—14 years. Stilling's pseudo-isochromatic tables were used as the main test, and those of Podestà and Nagel for further tests in all cases where Stilling was not read quickly and correctly. Finally, as many as possible of those showing a deficient colour sense, and a number of the doubtful cases, were tested with spectral colour mixtures. At this secondary examination the pseudo-isochromatic tables, arranged by S. Ishihara (Tokyo) were used together with Stilling's test. These tables are somewhat similar to those of Stilling and are very efficient.

Among the 1,270 girls, 11 were found to have a perception of colour so widely different from the normal, that they had to be declared as having "a deficient colour-sense" (4 dichromatics and 7 anomalous trichromatics). There were also a number of doubtful cases, which could not be classified accurately by the clinical tests mentioned above. Twelve of these were therefore selected and tested by means of spectral colour mixtures, the result being, that only one turned out to be a typical deuteranomalous, while the 11 others showed perfectly normal conditions with regard to a series of colour equations. The anomaloscope of Nagel was not at our disposal, but a modified Helmholtz apparatus for colour-mixing and a spectral apparatus made by Hj. Schiötz after Tscherning's model. These apparatus are as easy to use as the anomaloscope, and they are, if possible, more accurate, as they allow an investigation of the reaction of each person to a number of various colour equations. The equations employed were chiefly those given by B. Malling in his first work on colour-sense investigation, viz., in all cases a red-green equation (Rayleigh's equation). Many were tested with a blue-green equation and a white equation (of blue and yellow), and an endeavour was made to fix "the neutral point."

The investigation of school-girls' colour sense was continued in the autumn of 1919 on 930 girls at three private schools. This time the colour-sense was tested exclusively with Stilling's and Ishihara's colour tests, and 3 were revealed as being red-green blind to a considerable degree (dichromatics?), 6 to a lesser degree (anomalous trichromatics?). Besides, there was also a number of doubtful cases, which, however, after renewed testings must be considered as having normal colour-sense.

The two series thus include 2,200 girls with a total of 20=0·91 per cent. showing a deficient colour sense," or more specifically 7 deuteranopes and 13 deuteranomalous girls. In the case, however, of such a rare anomaly as colour blindness in females, these figures are too low to be regarded as a final value (and

besides, spectral colour equations were not sufficiently employed). All the same, the figures are not too low for a comparison with my results of similar investigations of men's colour sense, undertaken with the same tests.

During the last two years I have examined more than 2,000 males, and with the tests of Stilling, Podestà, Ishihara, and Cohn, I have found a total of 202 "with defective colour perception" (dichromatics and anomalous trichromatics), viz., out of

332 recruits	... ...	37	with defective colour-sense
633 schoolboys	...	66	„ „ „ „
1,040 applicants for railway posts*	... ...	99	„ „ „ „

Total 2,005 cases examined with 202 = 10·7 per cent. with defective colour-sense.

The result of these investigations should be, that in this country the proportion between the number of red-green blind males and females should be about ten to one. This is in accordance with other statistics; but to obtain a fairly homogeneous material, which can be used for comparison, it is necessary to go back to the extensive statistical work carried out during the years 1870-80, when Holmgren's wools were used alone to a great extent at the examination of colour sense both in males and females. After that time clinical colour tests have improved and multiplied, so that the actual percentage has steadily risen, as was naturally to be expected. Thus in 1855 George Wilson found 65 colour blind among 1,154 men (5·6 per cent.); Hjalmar Schiötz, 31 colour blind among 485 school boys with O. B. Bull's colour test (6·4 per cent.), and in 1914 H. Köllner, using Nagel's anomaloscope, found that up to 20 per cent. of males gave a colour perception different from the normal; but, perhaps, about one-half of these deviations are so slight, that they would never be of any importance in practical life.

In 1878, A. Daae, using Holmgren's wool-test, found:

Out of 205 boys, 10 colour blind, i.e., 4.88 per cent.

Out of 208 girls, none colour blind

In 1882, Lyder Borthen, with the same test, found:

Out of 423 boys, 15 colour-blind, i.e., 3.5 per cent.

Out of 117 girls, 1 colour blind.

The extensive collection of statistical material carried out in Sweden by Frithiof Holmgren with his own wool test must be considered very reliable:

Out of 32,165 men, 1,019 were colour blind, i.e., 25 per cent.

* The 1,040 railway applicants had not previously been tested. During the same period, 1,167 employees were tested, who had been tested before in other places and by other methods, some of them several times. Among these, 64 had a deficient colour-sense, i.e., 5·5 per cent. (among them several dichromatics).

Out of 7,119 women, 19 were colour blind, i.e., 0.26 per cent.

I will quote the following figures from O. E. de Fonteney's work, chiefly made by Holmgren's method:

Out of 5,287 men, 189 were colour blind, i.e., 3.57 per cent.

Out of 3,663 women, 16 were colour blind, i.e., 0.43 per cent.

A. Schmitz, working with an early edition of Stilling's pseudoisochromatic tables, found:

Among 2,215 men, 163 colour blind, i.e., 4.6 per cent.

Among 1,485 women, 5 colour blind, i.e., 0.33 per cent.

In the "Report of the Committee on Colour Vision, 1890-92," the following figures were stated:

Out of 10,846 men, 617 were colour blind, i.e., 4.156 per cent.

Out of 489 women, 2 were colour blind, i.e., 0.41 per cent.

Putting all these statistics together, we find a total of:

51,140 men, of whom 2,013 were colour blind, or 3·94 per cent.

13,090 women, of whom 43 were colour blind, or 0·33 per cent.

that is to say, there were nearly 12 times as many colour blind men as women.

In Joy Jeffries's book the following collective figures are to be found:

55,672 men, of whom 1,900 colour blind, or 3·4 per cent.

19,842 women, of whom 40 colour blind, or 0·2 per cent.

But these two statistics cannot be transformed into one, partly because Jeffries does not describe the tests employed, and partly because in all probability his statistics include some of the figures already quoted.

From the above it is evident that in the years 1870-80 red-green blindness was fairly evenly distributed in the various countries, and the same would undoubtedly be found to be the case at the present time. When, therefore, we find, that in Norway about 10 per cent. of men and nearly 1 per cent. of women are dichromatics or anomalous trichromatics, I have no doubt that similar figures would be found in other countries, if similar investigations with the same tests were carried out.

Some statistics appear to indicate red-green blindness as being more frequently found among Jews than among other races. Thus Cohn and Magnus in their paper of 1878 state, that they found 4·1 per cent. colour blind Jewish boys and only 2·1 per cent. among boys of other nationalities. "The London Committee" found 4·9 per cent. to be colour blind out of 949 Jewish boys, while out of 14,000 non-Jews the percentage was only about 4 per cent.

The question of colour blindness as relative to race, and the colour perception of primitive races is a very interesting one; Favre's paper should be called to mind on this point, as he refers to results obtained by a colleague in Algeria, viz:

Out of 203	Kabyles	5	colour blind.
„ „ 95	natives of Biskra	4	„ „
„ „ 81	Negroes	1	„ „
„ „ 62	Italians	1	„ „
„ „ 23	Jews	1	„ „
„ „ 12	Maltese	1	„ „

Rivers during his many travels carried out a number of investigations of the colour-sense. Among others he tested 80 natives of Upper Egypt, four of whom were red-green blind and made the characteristic mistakes with Holmgren's wools. Further, by the same test he found 43 definitely colour blind among 503 Todas, a hill-tribe of Southern India, while of 150 natives of Murray Islands in New Guinea not one confused red and green; but blue and green and blue and violet were constantly confused. The last fact might be taken to support the theory held by some who maintain that primitive races have a perception of colours less developed than our own, but on this point Meyer is undoubtedly right when he says: "Language affords no safe clue to sensibility. A colour name occurs when it is needful; where it is needless it will not be formed, be the sensibility to that colour ever so great. If we are to gauge the colour sense of a people by colour nomenclature, nearly every primitive people must be dubbed 'brown blind' or 'brown weak' in as much it is very rare to find a special word for brown."

This is very well illustrated by what J. H. Parsons writes in his book on Colour Vision: "Two companies of Nubians were travelling about in Germany in 1877, and were examined by Virchow and others. It was found that they used the same word for blue as for black and other dark colours, yet they sorted coloured papers and wools correctly."

Finally, Hirschberg in his History states, "If any one, like myself, has an opportunity of seeing an Egyptian cave mausoleum just opened after at least 4,400 years, he will, when seeing the gorgeously coloured pictures and hieroglyphs, quickly be convinced that the men who lived 1,500 years before Homer, possessed a perception of colour equal to our own, and more especially, they also perceived blue."

The statistical side of the problem of colour-sense is important enough, and an examination of the efficiency of the clinical tests is of great practical value. Still more interesting, however, is the study of red-green blindness as an *hereditary character.**

Perhaps no other branch of medical science offers a better field for the investigations of hereditary characters than ophthalmology,

*The author wishes to express his indebtedness to Dr. O. L. Mohr, who was kind enough to revise the genetic part of the manuscript.

partly because the ophthalmologist employs very exact methods of investigation, and partly because ophthalmology includes a number of anomalies and defects which have been and are considered hereditary (see Nettleship's very extensive research work, published in *Trans. of the Ophthal. Soc.*, 1902-1912).

The basis of our exact knowledge of the hereditary mechanism was first laid down by the Austrian Abbot, Gregor Mendel (1822-1884). His work was published in 1865, but it was not until after 1900 that the enormous importance of the work was recognized.

The fundamental principle of the Mendelian laws of heredity is the fact, proved by Mendel, that hereditary characters, which are brought together at fertilization, do not lose their independence. In following generations they will separate again, or, as this phenomenon technically is termed, segregate.

It is superfluous to mention that the hereditary material is carried from one generation to another by the sex cells.

These cells, the ripe sperm as well as the ripe egg, are termed *gametes*, the product of their union, i.e., the fertilized egg, is called a *zygote*. The gametes transmit the hereditary material from one generation to the other, i.e., they do not transmit the characters themselves, but they contain the corresponding hereditary factors or "*genes*." Each gamete carries one gene for the character in question, and when the gametes unite at fertilization, the zygote consequently will receive two genes for the same character. These two genes may be identical, and in this case the zygote—and the individual developing from this zygote—is said to be *homozygous*. But the two genes, which are brought together at the union of the gametes, may also be of different sort. The zygote—and the individual—is then said to be *heterozygous* for the gene in question.

Of two contrasted characters meeting at fertilization one may appear in the offspring, thus suppressing the other, and this character is said to be *dominant*, while the other is termed *recessive*.

An example will make this relation clear, and we may use the inheritance of eye colour in man as an illustration of the Mendelian principle of segregation. As is well known, in ordinary blue eyes only the retinal layer of the iris contains pigment; when pigment also is present in the stroma of the iris, the eye will represent a brownish iris colour. It has now been proved, that the pigmentation calling forth the brown colour, depends upon the presence of a *dominant gene*. Such dominant gene is, as a matter of convenience, marked by a capital letter, and in our case we can for instance take B (brown). The corresponding recessive character, in this case lack of pigment in the stroma, is marked with the corresponding small letter, here, b. When therefore a brown-eyed individual receives the gene for pigmentation from both parents, then he is homozygous for this character. The formula for the colour of his eyes will accordingly be

BB, the zygote receiving one B from the sperm and one B from the ripe egg. Six possibilities will occur:

I. If both parents are brown-eyed with the formula B B, the formulae of their gametes will accordingly be B, and all their children must become brown-eyed and homozygous.

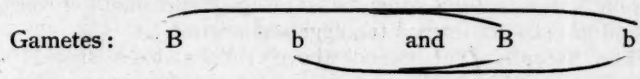
II. If both parents have blue or grey eyes, i.e., the formula b b, all gametes will have the formula b, and the formula of the offspring will be b b, that is to say, all the children will have grey or blue eyes, and are with regard to the colour of the eyes homozygous, like their parents.

III. If the parents' formulae are B B and b b the gametes will be

B, B and b, b

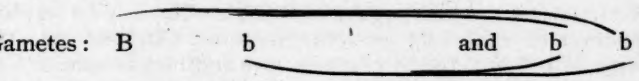
The offspring will have the formula Bb; the children will be heterozygous and because brown (B) is dominant they will all be brown-eyed.

IV. If both parents are heterozygous with regard to the colour of the eyes, having both the formula Bb, their gametes will be B and b and the following combinations will occur:



Because the gene for pigmentation is dominant, three children should have brown eyes, one being homozygous (BB) and the two others being heterozygous (Bb). For an external examination they will be like each other, but genetically they are of different constitution, which may be controlled in their descendants. The fourth child should from a theoretical point of view necessarily have blue eyes and be homozygous (bb).

V. If one parent has the formula Bb, and the other bb, the following combinations will be possible:



that is to say, half the children will be heterozygous, with brown eyes (Bb), the other half homozygous, with blue eyes (bb).

VI. A homozygous brown-eyed individual (BB) with a brown-eyed mate (Bb) will breed brown-eyed children only, one half being homozygous (BB) and the other half heterozygous (Bb).

From the above it will be seen that parents with brown eyes may very well have blue-eyed children, and that this depends upon

the genetical constitution of the parents. Blue-eyed parents, however, cannot produce children with brown eyes, they being always homozygous and always giving gametes free from the gene for pigmentation. Persons exist, however, having one brown eye and one blue, or one eye brown flecked, and this fact may be due to circumstances which prevent the pigment from developing in the eye.

With our present state of knowledge the genes are carried by the *chromosomes*, small rod-shaped or V-formed bodies, contained in the cell-nucleus. With one exception these chromosomes are, in the body cells, arranged in pairs, i.e., they form two homologous series, according to size and form.

During the ripening of the germ cells these two series separate so that the sex cells only contain one of these homologous series; and the segregation takes place at the so-called reduction-division, which occurs during the maturation of the eggs and sperms. In this division the two members of each chromosome-pair separate so that each daughter-cell only receives half as many chromosomes as the other cells of the individual. From these daughter-cells are formed the eggs and sperms.

The exception mentioned above relates to a single pair of chromosomes, which is only in the female present as a pair, while the male in his cells has but one member of the said pair. These chromosomes are called the sex-chromosomes or the X-chromosomes.

Since the female has two X's in her cells, each daughter-cell originating from the maturation or "reduction"-division mentioned, will receive one X. Since the male cells only contain one X-chromosome, this element will, at the maturation-division of the male sex-cells, pass undivided to one of the two daughter-cells. The other will receive no X-chromosome. Accordingly two kinds of spermatozoa are formed, one half containing an X-chromosome, *the other half without such an element.*

At the fertilization accordingly two possibilities present themselves. An egg, which always contains an X, may be fertilized by a sperm also containing an X-chromosome. In this case the offspring will receive two X-chromosomes and be a female.

If, on the other hand, the egg is fertilized by a sperm without an X-chromosome, the offspring will only receive the single X-chromosome of his mother and be a male.

Egg		Sperm		Zygote
X	+	X	=	XX (♀)
X	+	O	=	XO (♂)

The correctness of this chromosome theory of the determination of sex, first fully worked out by E. B. Wilson (1905-06), may now

be regarded as sufficiently established through an abundance of cytological and genetic evidence.

In man, which for our present purpose is of particular interest, the female cells, according to the results of de Winiwarter, contain 46 + 2 X-chromosomes, the male cells 46 + 1 X. Accordingly all the eggs contain 23 + X, and the sperms are of two types, one half containing 23 + X, the other half only 23 chromosomes.

At the fertilization the following two possibilities are open:

Egg		Sperm		
(23 + X)	+	(23 + X)	= 46 + 2 X	the female chromosome number
(23 + X)	+	23	= 46 + 1 X	the male chromosome number

In spite of the extensive work during the 19th century on red-green blindness as an hereditary character, it was very difficult to understand, how this anomaly was inherited, why it may disappear in one or more generations only to re-appear later on. Other features in the hereditary type of the anomaly were also quite inexplicable, e.g., that there are about ten times more colour-blind men than women, and that colour blind men never have colour-blind children, unless they have married a woman with the hereditary predisposition. It should be mentioned in this connection that an explanation of the peculiar sex-linked inheritance of colour blindness in man, conforming with the chromosome-theory of sex-determination, was already put forward by E. B. Wilson.

If we assume that colour blindness is a recessive character in Mendel's sense, and that the gene for colour blindness is carried by the sex chromosome, then every obscure feature in its inheritance becomes perfectly clear.

A colour blind man carries, on this assumption, in his single sex-chromosome the gene for this anomaly. When he marries a normal woman, his daughters will receive one affected sex-chromosome from himself (their father) and one normal sex-chromosome from their mother. Since colour blindness is a recessive character, the anomaly will not manifest itself in these females, the dominant gene for normal colour sense being present in their other sex-chromosome. Such a woman will therefore herself have a normal colour sense, but nevertheless, if married to a normal man, be able to transmit the gene for colour blindness to half of her sons and half of her daughters, (she will be a "conductor.") Of these the daughters will be like their mother, since the action of the recessive gene for colour blindness is counteracted by the normal sex-chromosome, which they have obtained from their mother (they are conductors).

The sons mentioned will be colour blind, since their cells contain but one sex-chromosome, and in this case an affected one.

A red-green blind woman must necessarily have received the hereditary gene from both parents. Both her sex-chromosomes must carry the gene causing colour blindness, and the sex-chromosome contained in her eggs will be of the same affected type.

A character of this type is accordingly transmitted from the affected grandfather through his apparently normal daughters to half of his grandsons, as was first clearly pointed out by Horner in 1876.

Characters, which show this type of criss-cross inheritance, are called *sex-linked characters.* Several cases are known from experimental genetic work, and in man the hereditary red-green blindness, a certain form of night blindness, familial atrophy of the optic nerve (Leber's disease), and haemophilia belong to this group.

In the following we will more closely consider the hereditary type of colour blindness and the various combinations of the possible marriages between affected and normal individuals.

If we denote the recessive gene for colour blindness by little c and the corresponding dominant gene for normal colour vision by big C, then a normal female will be of the constitution C C a normal male of the construction Co, the zero indicating that he, having but one sex-chromosome in his cells, may only carry the gene for colour sense in one dose.

In marriages involving individuals of which one or both carry the gene for colour blindness, the following five possibilities are open:

I. A red-green-blind man (c o), marrying a red-green-blind woman (c c), will have red-green blind children only.

female gametes c ; c
male „ c ; o
female zygotes c ; c
male „ c ; o

II. When a female conductor (C c) marries a colour blind (c o), half of the sons and half of the daughters will be colour blind:

female gametes C ; c
male „ c ; o

female zygotes: C c (conductor) and c c (colour blind).
male „ : C o (normal) and c o (colour blind).

III. A red-green blind man (c o) and a normal woman (C C) will have normal children only, all daughters, however, being conductors.

female gametes C ; C
male gametes c ; o

female zygotes: C c (conductor)
male „ C o (normal)

IV. A normal man (C o) and a red-green blind woman (c c) will have red-green blind sons only, all daughters will receive the

gene for colour blindness in single dose and will accordingly be conductors.

female gametes c ; c
male „ C ; o
female zygotes C c (conductor)
male „ c o (colour blind)

V. A normal man (C o) and a conductor (C c) will produce sons of which half are red-green blind, and half normal; all daughters will be apparently normal, but half of them will be conductors.

female gametes: C ; c
male „ C ; o
female zygotes: C C (normal) and C c (conductor)
male „ C o „ and c o (colour blind)

On the assumption that these rules are constant, and that the statistical material concerning colour blindness is approximately correct and sufficiently extensive, it should be possible to calculate how often these different types of matings occur, and also how many females are conductors. It is also possible from the percentage of colour blind men to calculate how many colour blind women there are, and vice versa.

As stated above, a male is not colour blind unless his mother is either colour blind or a conductor, and it is easy to calculate how many conductors would be needed in order to produce the 10 per cent. of colour blind men. The percentage of colour blind women, as mentioned above, was about 1 per cent., and they would produce about 1 per cent. of colour blind men, as all their sons would inherit the anomaly.

Conductors transmit the anomaly to half of their sons only, wherefore there would be needed about 18 per cent. conductors to produce the remaining 9 per cent. of colour blind males. This figure is startlingly high, but perhaps not far from actual truth.

Using the 10 per cent. males as a starting point, the number of colour blind women may be estimated. It should be recalled that colour blind female offspring can only be expected in the following marriage-combinations: c c + c o (all daughters colour blind) and C c + c o (half the daughters colour-blind).

How often do these combinations occur?

Because there are 10 per cent. of colour blind men, a woman's chance of marrying such a man is $\frac{1}{10}$ and if a percentage of 18 is assumed for female conductors, a man's chance of marrying such a woman is $\frac{1}{5.5}\left(=\frac{18}{100}\right)$. The probability of a marriage where the man is colour blind and the woman a conductor may, therefore, be

estimated as being $\frac{1}{55}$ (1.8 per cent.), and according to the above (alternative II), in principle half the number of daughters in such a marriage would be colour blind, and our calculations must lead to 0.9 per cent. for colour blind women.

To these would have to be added the female offspring of all marriages between two colour blind persons, a combination which probably does occur in 0.1 per cent. of all marriages. These would make another 0.1 per cent. of colour blind women, which added to our previous 0.9 per cent. make 1 per cent., a result which is fairly well in accordance with the results of the statistics dealt with above.

The author wishes to express his gratitude to Dr. G. H. M. Waaler, who has been kind enough to control these results from a mathematical point of view.

Dr. Waaler writes as follows:

"The author has requested me to discuss mathematically the problem of colour blindness on the assumption that the genetic principles discussed above are reliable in case of a recessive sex-linked character.

With regard to colour blindness, mankind is divided into five varieties, viz.:—

1. Normal men (m_0), who in the following will be assumed to form u per cent. of all men:—
2. Colour blind men (m_1) = x per cent.
3. Normal women (f_0) = v per cent.
4. Female conductors (f_1) = y per cent.
5. Colour blind women (f_2) = z per cent.

The six possible marriage-combinations in any population would be the following:—

I.	$m_0\ f_0$	will be	$\frac{u}{100} \cdot \frac{v}{100}$	of all marriages.		
II.	$m_0\ f_1$	,,	$\frac{u}{100} \cdot \frac{y}{100}$	,,	,,	
III.	$m_0\ f_2$	,,	$\frac{u}{100} \cdot \frac{z}{100}$	,,	,,	
IV.	$m_1\ f_0$	,,	$\frac{x}{100} \cdot \frac{v}{100}$	,,	,,	
V.	$m_1\ f_1$	,,	$\frac{x}{100} \cdot \frac{y}{100}$	,,	,,	
VI.	$m_1\ f_2$	,,	$\frac{x}{100} \cdot \frac{z}{100}$	,,	,,	

the total of all these possibilities being 1.

Our problem is to find the mathematical relations between the said five frequencies, more especially for colour blind men (x per cent.), female conductors (y per cent.) and colour blind women (z per cent.).

Let us assume that the percentage keeps invariable through several generations, as it presumably does in a large city; moreover, that colour blind individuals are as fertile as normal ones, and finally that no selection will take place.

Beginning with colour blind women, representing half the daughters resulting from the marriages of type V. and all daughters in marriages of type VI, we get the following formula with regard to the percentage of z:

$$\frac{z}{100} = \frac{1}{2} \cdot \frac{x}{100} \cdot \frac{y}{100} + \frac{x}{100} \cdot \frac{z}{100} \text{ giving}$$

$$z = \frac{x}{100} \cdot \left(\frac{y}{2} + z \right) \ldots (1).$$

In the same manner the percentage of colour blind men may easily be expressed as follows:

$$\frac{x}{100} = \frac{1}{2} \cdot \frac{u}{100} \cdot \frac{y}{100} + \frac{1}{2} \frac{x}{100} \cdot \frac{y}{100} + \frac{u}{100} \cdot \frac{z}{100} + \frac{x}{100} \cdot \frac{z}{100}, \text{ giving}$$

$$x = \frac{I}{2} \cdot \frac{y}{100} \cdot (u + x) + \frac{z}{100} \cdot (u + x) \text{ or, as } u + x = 100,$$

$$x = \frac{y}{2} + z \ldots . (2)$$

From (1) and (2) we obtain the simple formula: $z = \frac{x^2}{100} \ldots . (3)$

If a similar equation were constructed for y (i.e., the frequency of female conductors), and a solution were sought with regard to the three unknown values, the three equations would be found to be identical, that is to say, there is an infinite number of ***sets of values*** for the three frequencies (x, y, and z). If, however, one of these values is definitely known, the equations (2) and (3) enable us to find the other two corresponding values.

Thus assuming the value found by the author for colour blind men as being the most reliable ($x = 10.07 \pm 0.45$) $\frac{z}{=}$ – i.e., the colour blind women – should be $= \frac{10.07^2}{100} = 1.01$ per cent., and

the female conductors, $y = 2(x-z) = 18.12$ per cent. [calculated by (2)]

Now out of 2,200 women 20 have been found to be colour blind, which represent a percentage of 0.91 ± 0.14, which accords very well with our calculation.

From a purely mathematical point of view such a ***set of values 1.01 – 10.07 – 18.12*** should remain constant for an infinite future, and it is probable that it has existed for a considerable period.

From the above reflections we may be justified in drawing the conclusion, that the values obtained by the collective statistics in 1870-80, viz., 3.94 per cent. colour blind men and 0.33 colour blind women, may be explained through insufficient testing methods, as such relative values could not possibly co-exist in any population, still less remain stationary. On the assumption, that these values were correct, the number of colour blind women in the next generation would be reduced to 0.15 per cent., and the only factor which might keep up a percentage of 0.33 would be a relatively high percentage of female conductors, viz., 16.10, which cannot possibly exist side by side with the low values for colour blind men and women. The percentages 3.94 and 0.33 cannot, therefore, co-exist in the long run, they cannot correspond.

On the other hand, the relative proportion between colour blind men and women, as given in the old statistics, viz. 1 : 10 or a little more, allow the conclusion, that colour blindness actually occurred to the same extent at that time, as it does now. The proportion 1: 10 can exist exactly, only for frequency corresponding to 1 per cent. of colour blind women, 10 per cent. of men, and 18 per cent. of conductors, and when the proportion at that time (1870-80), was about one to ten, the actual values for colour blind men and women must have been just about 10 per cent. and 1 per cent.

Among the possible corresponding values, i.e., values dependent on the condition, that the percentages shall remain constant, and which in their turn are a condition for such constancy, the following might be mentioned :

4	p.c.	colour bl.	men	demand	7,68	p.c.	conductors	and	0,16	p.c.	colour bl.	women	(proportion 1 : 25)
9	,,	,,	,,	,,	16.38	,,	,,	,,	0.81	,,	,,	,,	(,, 1 : 11)
10	,,	,,	,,	,,	18.00	,,	,,	,,	1.00	,,	,,	,,	(,, 1 : 10)
10.07	,,	,,	,,	,,	18.12	,,	,,	,,	1.01	,,	,,	,,	(about 1 : 10)
11	,,	,,	,,	,,	19.58	,,	,,	,,	1.21	,,	,,	,,	(,, 1 : 9)
20	,,	,,	,,	,,	32	,,	,,	,,	4	,,	,,	,,	(,, 1 : 5)

This proves that the proportion actually found during research work in colour blindness may be employed as a control for the correctness of the values found, as strikingly seen in this case.

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(To be continued.)

DR. EDRIDGE-GREEN'S THEORIES OF VISION

(continued)

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III.—Colour Names

Dr. Edridge-Green divides the spectrum into "psycho-physical units." Thus, the normal person sees six colours—red, orange, yellow, green, blue and violet. Only a few persons see an additional

colour, indigo, between the blue and the violet. A further subdivision is into "absolute psycho-physical units," according to the number of monochromatic patches which can be distinguished in the spectrum.

He says that colour blind people have fewer psycho-physical units, and may therefore be classified according to the number of colours seen into penta-, tetra-, tri-, and di-chromics. The dichromics see only two colours—red and violet; the trichromics three—red, green, and violet; the tetrachromics four—red, yellow, green, and violet; the pentachromic five—red, yellow, green, blue, and violet; the hexachromic six—red, orange, yellow, green, blue, and violet.

Dr. Edridge-Green's actual words are (p. 178): "One man will declare that there is no difference in colour over the whole spectrum, but simply variations in brightness; another will say that the spectrum is tinged with red at one end and violet at the other, the central portion of the spectrum being colourless; another, that the spectrum consists of two colours, red and violet, with a small colourless interval; another, that the spectrum contains three colours, namely: red, green, and violet, the orange and yellow regions being designated red-green, and the blue region green-violet. Another will say that he sees four definite colours; others, five or six, and a few, seven." The matter is, however, not quite so simple as this statement implies. The colour blind are not consistent in the manner in which they name the colours of the spectrum. For example, an individual will often call the bright orange green if patches of the spectrum are shown passing in the direction from red to violet, but he will immediately afterwards call the same colour orange or reddish-yellow in passing from violet towards the red end. Many other examples of a similar nature might be cited.

Yet, in determining the class to which any person belongs, Dr. Edridge-Green attaches much importance to the names given to the colours. Now it has always been held hitherto that little importance is to be attached to the names given to colours by the colour blind, and there is good reason for the utmost caution in this respect. From the psychological point of view most people will agree with Hering that there are only four fundamental colours (excluding black and white), viz., red, yellow, green, and blue. The other colours in the spectrum can be analysed subjectively into these or mixtures of two of these colours, e.g., orange arouses the sensations of both red and yellow, and there are similar transition colours, which have not received distinctive names, between yellow and green, and green and blue. Of orange, Dr. Edridge-Green says, "to me orange is most definitely a fundamental sensation. I cannot see any trace of either red corresponding to the ruby glass or yellow in pure orange. I am quite unable to analyse orange

into red and yellow and the term reddish-yellow does not describe orange to me " (Physiology of Vision, p, 169). I do not think that this is the experience of most people with normal colour vision.

Now, let us suppose for the sake of argument, that colour blind people are really divided into dichromics, trichromics, etc., as Dr. Edridge-Green postulates. Such a person is born into the world with, for example, only two colour sensations. He sees all sorts of gradations of red and violet in various degrees of brightness and saturation. He learns, however, from intercourse with other people that these people have many colour names. Although he can see little or no difference in colour between a strawberry and a strawberry leaf, he finds one is called red, the other green. He, therefore, learns to use all these names, though it must be very difficult for him to know why colours similar to him are called by different names under different circumstances. So long as he is dealing with objects which are characteristic in shape or other attributes, he will probably use the right colour names; but if he is confronted with the colour divorced from these attributes, e.g., a circular patch of coloured light, he is likely to make mistakes. His sole adventitious guide in this case is the brightness of the light. According to most observers, though Dr. Edridge-Green differs from the generally accepted views (*vide infra*), in the majority of the colour blind there is a definite relationship between their appreciation of colours and the brightness of the lights. In one class, for example, reds look much less bright to them than to the normal person. They are, therefore, accustomed, in the absence of other adventitious aids, to call very dull lights red.

Hence, in naming the colours of the spectrum, the colour blind, though having fewer colour sensations than the normal, are accustomed to use several or all of the names in general use. Consequently they make egregious mistakes. Now, these mistakes appear to the onlooker to be quite meaningless. It is only after prolonged experience that the colour names used by the colour blind are found to possess a certain degree of consistency; but, at best, the names given to the colours are a very uncertain criterion of the type of colour blindness. That with increasing knowledge of this difficult subject they will attain greater value as indicators cannot be doubted; many difficulties in this direction have already been cleared up by the Young-Helmholtz theory (*Cf.* paper by H. Hartridge in the last number of this Journal).

When we look at the question of colour names from another point of view they become of paramount importance, viz., when it becomes a question of deciding whether a colour blind person is likely to be dangerous as an engine driver, etc. Here, if a man calls green red, or vice versa, it is obvious, without any further evidence

of the exact nature of his colour defect, that he is unfitted for such an occupation.

So far as colour names are concerned, then, I consider that they are a very unstable foundation for the scientific classification of various types or degrees of colour blindness. If we examine Dr. Edridge-Green's records of dichromics (pp. 186-189), we find that, though he says they are all dichromics, the colour names which the individuals used varied from 2 to 6, excluding such names as red-green, blue-green, etc. Dr. Edridge-Green says (p. 179) that this—applying different colour names to the various divisions of the spectrum—" only occurs when the examinee has some idea of the region presented to him." I do not think that most examiners would agree with this view.

Further evidence of the difficulty of the colour blind in naming colours is given by their invention of terms like red-green and green-violet. The former is not uncommon, but I do not remember myself to have heard the latter. Now red-green to me, and I imagine to most people, is meaningless, except in so far as experience has taught that its use is a sign of colour blindness. Dr. Edridge-Green's views on " red-green " and yellow are rather obscure. He says (p. 141) " It is, however, much more probable that the effects of a mixture of red and green are not actually the same as those of a simple yellow, but are physiologically indistinguishable, the retino-cerebral apparatus not being sufficiently developed. The sensation yellow having replaced that of red-green of former ages the two have become indistinguishable. The physical and mathematical aspects of this point of view have been shown in a a very able paper by Houstoun. A corollary to this point of view is that when the colour sense has been still further developed a mixture of red and green will no longer match a simple yellow but will appear as a distinct colour in the same way as a mixture of red and violet make a perfect match with green for the dichromic, but the normal sighted readily distinguish one as green and the other as purple."

IV.—Discrimination of Hue

Dr. Edridge-Green, after dividing the spectrum into " psycho-physical units," according to colour names, further subdivides it into " absolute psycho-physical units " according to the number of monochromatic patches which the individual can discriminate. For this purpose he has devised the colour-perception spectrometer. It is used as follows :—" The observer should first ascertain the exact position of the termination of the red end of the spectrum, the left-hand shutter being moved across until every trace of red just disappears. The position of the pointer on the left-hand drum is noted, and the wave-length recorded. The left drum is

then moved so that the shutter is more towards the middle of the spectrum. The right-hand drum is then moved until the pointer indicates the wave length recorded as the termination of the red end of the spectrum. The observer then moves the left hand shutter in and out until he obtains the largest portion of red, which appears absolutely monochromatic to him, no notice being taken of variations in brightness, but only in hue. The position of the index on the left hand drum is recorded. The left-hand shutter is then moved more towards the violet end of the spectrum, the right hand shutter being placed at the position previously occupied by the left-hand shutter. In this way the whole of the spectrum is traversed until the termination of the violet end of the spectrum is finally ascertained with the right-hand shutter."

The object of this instrument is to determine the *smallest* monochromatic patches into which the spectrum can be divided. I think it is not difficult to prove that in reality it measures the *largest* monochromatic patches.

The mind is so constituted as to appreciate relatively sudden change in sensations, not gradual change. By very gradual increase or decrease of temperature a frog may be boiled or frozen to death without making the smallest movement. Moreover, the successive is more easily and earlier apprehended than the simultaneous, for simultaneous sensations have a tendency to fuse. No more perfect method of obtaining the maximum fusion could be found than that of viewing simultaneously the perfect gradations of colour in the spectrum. When more delicate methods are used totally different results are obtained, as has been repeatedly proved—notably by König and Dieterici, Uhthoff, F. Exner, Steindler, and William Watson. Lord Rayleigh stated that he could distinguish between the wave-lengths included in a monochromatic division to the extent of discriminating between the colours of the two D lines (*Proc. Roy. Soc.*, B., 1910, Vol. LXXXII, p. 458). Dr. Edridge-Green traversed this statement and attributed the error to " the admixture of small quantities of white and coloured light and to certain physiological influences " (*Proc. Roy. Soc.*, B., 1911, Vol. LXXXIV, p. 116). Dr. William Watson conclusively disproved any such influence of admixture with white light (*Proc. Roy. Soc.*, B., 1911, Vol. 84, p. 118), and found that 14 observers gave the following mean values with sodium light: Width of monochromatic patch=4.5 $\mu\mu$; difference in wave-length easily detected as a change in hue= 1.4 $\mu\mu$. The evidence against the validity of Dr. Edridge-Green's method for discriminating differences of hue in the spectrum is overwhelming. (See my " Introduction to the Study of Colour Vision," p. 30.)

I think, however, that the observations made with the spectrometer might afford valuable data for statistical enquiry. The

classification of the number of maximal monochromatic patches of a considerable number of colour blind people might be expected to give evidence in favour of some definite grouping of the colour blind. It does not appear to me to give very strong support to Dr. Edridge-Green's grouping. For example, his 3 examples of trichromics have 10 monochromatic patches (p. 198), whereas in his examples of dichromics the numbers vary from 2 to 11 (pp. 186-9). Hexachromics are said to have 18 (p. 202), and tetrachromics 10 to 14 (p. 201).

V.—Colour Mixture

"All the colours of the spectrum and of nature can be imitated by mixtures of three selected spectral colours, so that in this sense colour vision is undoutedly trichromatic" (p. 136). This statement—which, however, is not strictly accurate—shows that Dr. Edridge-Green accepts the fundamental fact of colour mixtures, upon which the Young-Helmholtz or three-components theory is chiefly based.

Such a striking feature of colour vision demands a precise explanation from any comprehensive theory, yet little is said about it in Dr. Edridge-Green's latest book. In his Hunterian Lectures (1911, p. 23) he says: "We must therefore explain in another way the apparent trichromatism of normal colour vision, which is so well known to every photographer, especially those who are concerned with colour photography. If my theory of the evolution of the colour sense be the correct one, and we have cases of colour blindness corresponding to every degree of the evolutionary process, we have an explanation of the facts. In past ages all saw the rainbow made up of only three colours—red, green and violet. When a new colour (yellow) appeared between the red and green, it is obvious that a mixture of red and green would give rise, not to red-green, but to to the colour which had replaced it—namely, yellow." This does not appear to me to be a satisfactory or in any sense a complete explanation, and we have already seen (this Journal, p. 330) that Houstoun is in a similar difficulty.

It is true that *more* than three spectral colours will also explain the facts of colour mixtures. Thus, Bayliss (Principles of General Physiology, 1918, p. 524), a supporter of Dr. Edridge-Green, says: "The Young-Helmholtz theory assumes that there are only three primary colour sensations, red, green and violet. Now, while it is true that any colour may be formed by mixtures of these in appropriate proportions, it is also true that more than three primary sensations would also serve the same purpose, three is, in fact, the minimum." In this connection may I refer Prof. Bayliss to another passage in his book (p. 66)? "It seems to me that the well known principle of logic called "William of Occam's Razor"

may legitimately be applied to such a case as the one before us: "*entia non sunt multiplicanda praeter necessitatem.*" Sir William Hamilton (1853) gives a more complete form in his "Law of Parsimony": thus, "Neither more, nor more onerous, causes are to be assumed than are necessary to account for the phenomenon." So far as colour mixtures are concerned, more than three colours are "*praeter necessitatem,*" but I am not prepared to deny that the three-components theory does not account for all the facts of colour vision.

VI.—The Yellow Sensation

It is of fundamental importance to Dr. Edridge-Green that he should prove yellow to be a simple sensation and not the combined effect of stimulation of red and green sensations. He has dogmatically stated 16 propositions (pp. 141-146) in favour of the simple character of the yellow sensation; and the reader might well be led to think that there are no arguments on the other side, for none indeed are referred to. Yet this has already been a battle-ground of the Young-Helmholtz and Hering combatants, and was most carefully investigated by Burch, a very unbiassed observer.

Thus, Dr. Edridge-Green says:—"The eye may be fatigued for red and green without altering the hue of spectral yellow" (p. 143).

Burch (*Phil. Trans.*, B, CXCI, 1898) says that in red fatigue the red end is shortened, but the green "appears with full intensity *at (the) D (line) and reaches more faintly almost as far as (the) C (line)*" (*loc. cit.*, p. 6). "The eye, blinded for red, sees pure green from about E to D or even almost to C" (*loc. cit.*, p. 15). In green fatigue "the green disappears, but its place is occupied by the red and blue, *which not only meet, but overlap*" (*loc. cit.*, p. 6). Burch confirmed these observations on 70 people (*loc. cit.*, p. 19). In another place (*The Ophthalmoscope*, Vol, XI, 1913, p. 145) Burch says:—"It is a matter of every day demonstration in the laboratory that, using moderate stimuli, with persons of normal colour sensation, yellow does change to green after fatigue to red and to red after fatigue to green. And I am bound also to note that persons whose green sensation is weak fail to see this change in the colour of yellow after fatigue."

Dr. Edridge-Green: "If the eye be fatigued with pure spectral yellow light the spectrum will appear to have lost its yellow, and though yellowish-red or yellowish-green will appear less yellow, the terminal red of the spectrum will not be affected" (pp. 142-3).

Burch: Fatigue with orange or yellow affects not only the appearance of the orange or yellow, but that of the red or green also. "With light from C the effect upon the green is very marked, and it is evident that in the fatigue produced by light from D, the red and the green colour sensations are about equally involved. After a very brief exposure to light of this wave-length the spectrum,

although visible from A to K, is seen to be uniformly dulled from A to *b*, the red appearing brick-red, the green yellowish and dingy. *A more protracted exposure to the light abolishes the red and green sensations altogether.*" (*Phil. Trans., loc. cit.*, p. 8). Attention may be directed to the plates which accompany Burch's paper, showing the appearances of the spectrum after fatigue with spectral rays.

Dr. Edridge-Green: If the intensity of spectral yellow be gradually reduced, "the yellow becomes whiter and whiter until it becomes colourless, but does not change in hue" (p. 143). "There is no change in tone in pure yellow or pure blue as the intensity is diminished" (p. 170).

Burch (*Proc. Roy. Soc.*, B. 76, 1905, p. 214): "It follows that a colour like that of the sodium flame which, to a normal eye, excites the red and green sensations in almost equal proportions will, if the intensity is greatly reduced and the eye sufficiently rested, excite a larger proportion of green. This I have put to the test of experiment. The results are interesting as bearing on the precautions necessary in such cases . . . . But in the spectroscope . . . . *the sodium lines appeared pale green when of the minimum visible intensity.*" (The italics are in the original).

Dr. Edridge-Green: "Spectral yellow after colour adaptation to green still appears yellow and not red" (p. 144). This is directly opposed to Burch's results. After sunlight from E, "which seems to correspond very nearly with the point of maximum sensitiveness to green . . . . . if the slit is narrow the spectrum seems to consist of two colours only, namely, orange-chrome and ultramarine, passing into each other through a neutral tint very difficult to describe. . . . . But on opening the slit the orange changes to a brilliant scarlet, reaching almost up to the blue, with only a narrow band of neutral tint between, and the violet is also plainly differentiated from the blue as in the normal spectrum. . . . . By simply opening or closing the slit the change can be effected at any time during the duration of green-blindness, showing that the orange hue of the red is due to the admixture with it of a subjective green (the positive after-effect), the intensity of which is a function of the time and not of the width of the slit at the moment, and which is therefore unnoticed when the brightness of the spectrum is sufficiently increased." (*Phil. Trans., loc. cit.*, pp. 8-9).

Dr. Edridge-Green: "The after-image of pure spectral yellow is first seen as a bright yellow positive after-image; this does not change to green on becoming negative" (p. 144).

Burch: "The positive after-effect of light from between D and C is at first red. But it comprises two dazzle-tints red, and green, of which red soon vanishes, leaving green." (*Phil. Trans., loc. cit.*, p. 7).

Burch states definitely: "I have entirely failed, though I have sought it carefully, to detect any physical evidence of a separate sensation of yellow." (*Phil. Trans.*, *loc. cit.*, p. 16). Sir William Abney and many other observers have arrived at the same conclusion. Whether they are right or wrong it is unjustifiable for Dr. Edridge-Green to convey the impression that his arguments are unassailable.

VII.—The relationship of Colour and Brightness in the Colour blind

According to Dr. Edridge-Green (*Proc. Roy. Soc.*, B. 82, 1910, p. 458, and elsewhere) light perception and colour perception are quite distinct, and cases of colour blindness can be divided into two classes, according as the defect is one of light perception, or one of colour perception or differentiation without any defect in light perception. Both defects may be present in the same individual. "Abnormalities and defects of light perception may be subdivided as follows: (1) Increase or diminution in the visible range of the spectrum. (2) Defective sensibility for certain wave-lengths. (3) Increased sensitiveness for certain wave-lengths. (4) Variations in the maximum of the luminosity curve. (5) Increase or defect in the power of dark adaptation (a) very rapid or slow dark adaptation, (b) very complete or imperfect dark adaptation" (p. 206).

The work of Sir William Abney and his collaborators, and of many other observers, is diametrically opposed to the independence of the luminosity and colour sensations which Dr. Edridge-Green asserts without proof. Dr. William Watson (*Proc. Roy. Soc.*, A, 88, 1913, p. 404) devoted an exhaustive investigation to this point, with special reference to Dr. Edridge-Green's assertion, and in a subsequent communication (*Proc. Roy. Soc.*, A, 89, 1913, p. 36) he was able to disprove the statement on one of Dr. Edridge-Green's own cases. For a prolonged period experiments by the flicker photometric method were carried out by Sir William Abney, Dr. Watson and myself on nearly all the cases of colour blindness which came under our observation, with results which entirely confirm Dr. Watson's conclusions. For reasons which are fully explained by the Young-Helmholtz theory the relationship between colour perception and brightness perception is more easily demonstrated in the so-called "red-blind group," but with suitably delicate methods it is equally demonstrated to be true of the more common "green-blind" variety and the so-called "anomalous trichomats." Dr. Edridge-Green has never brought forward any experimental evidence to disprove these results, and until he does so no unbiassed critic will be impressed by his *ipse dixit*.

(To be concluded.)

SOME PLASTIC OPERATIONS ABOUT THE LIDS AND SOCKET*

BY

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1.—Apostasis and Ectropium of the Lower Lid

We sometimes meet with cases where the lower lid stands away from the globe, with or without slight ectropium of the margin of the lid. They are seen after recent burns and wounds, and are accompanied by constant lacrimation, owing to exposure of the conjunctiva and lack of apposition of the punctum lacrimale to the globe. Similar conditions are also found among elderly people in whom the tissues are wanting in tone.

The procedures usually adopted to try to bring about contact of the lid and globe are either to excise a triangular portion of skin at the inner canthus, or to shorten the lid by removing a triangular

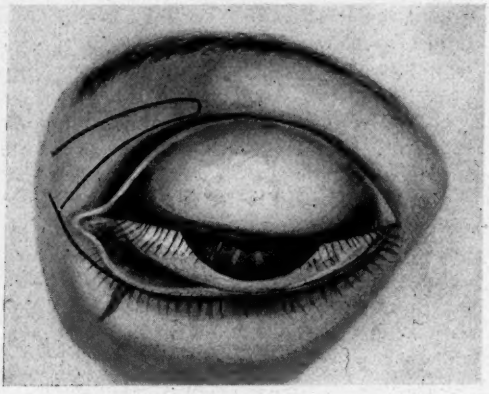

FIG. 1.

portion of the "cartilage." The former generally fails to achieve the end, and the latter is a delicate and rather tedious operation. I prefer to work as follows:

My aim is to provide a sling with the aid of a pedicle flap taken from the loose tissue between the upper lid and the eyebrow (see Figs. 1 and 2). The arrangement not only tends to improve the position of the lid as a whole, but it also helps to invert the punctum.

*Read before the Midland Ophthalmological Society, March 30, 1920.

The base of the flap is placed above a line drawn inwards from the internal canthus (or outwards from the external canthus). The height above this level depends upon the extent to which the

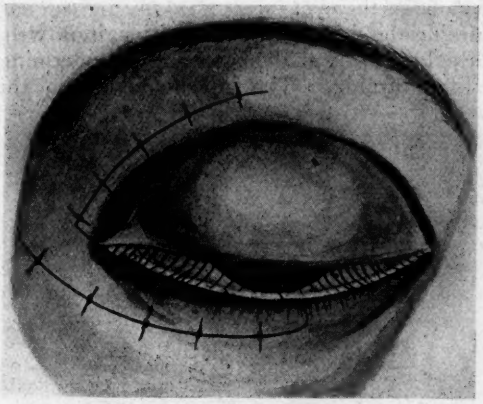

FIG. 2.

lid has to be lifted. It is better to put it too high than too low. ¾-inch will meet an average case. From here the flap extends upwards, above and parallel to the principal fold of the upper lid,

FIG. 3.

length and width of course corresponding to the size and character of the defect to be remedied.

From the base of the flap an incision is carried downwards along the margin of the lower lid. The skin is freely undermined, care being taken to keep as near the surface as possible, and any cicatricial tissue is divided sufficiently to allow the lid to lie easily against the globe of the eye.

Before turning the flap down into position it is well to incise it slightly on the lower side at the base, and to undermine the latter a little to facilitate turning. The flap should be kept thin to obviate

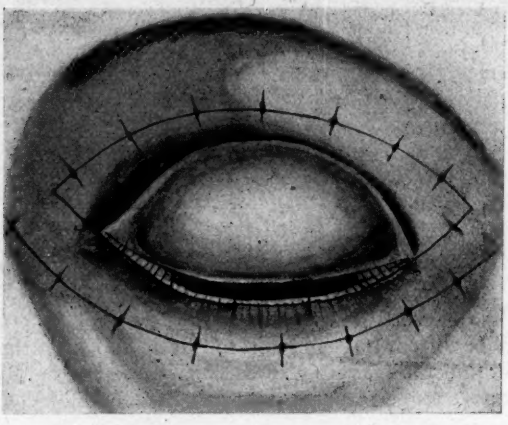

FIG. 4.

an unsightly bulge when is is placed in its new position. Finally, the lid is hitched up, the flap put moderately on the stretch and sutured, silk being used near the lid margin, and horse hair or gossamer silkworm gut elsewhere.

The operation does not interfere in the least with the free movement of the upper lid, and the scars are quite invisible in a few weeks. It can be applied to both ends simultaneously if desired, and if necessary a continuous strip can be taken from the position indicated, with a base at each end, and brought down to form a complete new covering for the lower lid (Figs. 3 and 4).

II.—Contracted Socket

(*a*) *Cicatricial Bands*

Cases in which the artificial eye is forced out of the socket by bands of cicatricial tissue may be put right by taking a flap from the area just discussed, i.e., the interval between the upper lid and the eyebrow, and passing it through a temporary opening in the upper lid to cover the raw surface left by dividing the bands.

There are several advantages attached to this procedure. In the

first place, it is far easier to work with a pedicle flap than with an isolated graft. Secondly, the latter very often does not take, whereas it is the exception for the former not to live. And thirdly, the flap itself while retaining these advantages can be kept very thin, so that comparatively little shrinkage will follow.

Healing is allowed to take place for a week before the base is divided and the opening in the lid closed. By this time the flap

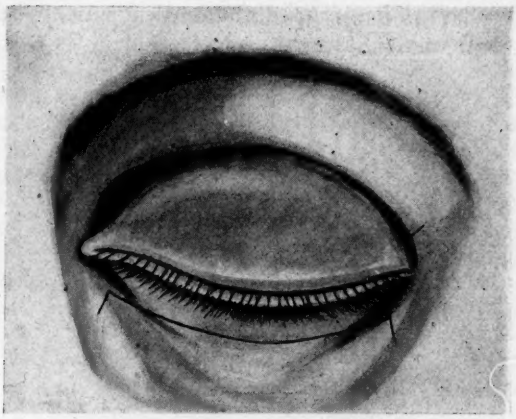

FIG. 5,

has become firmly adherent and is sure to live, and shrinkage has been made good by an additional portion of the pedicle having been drawn into the socket in the process of healing.

(*b*) *Shelving Floor*

An artificial eye sometimes cannot be retained because there is no lower fornix. To remedy the condition a simple operation, such as the "suture" operation of Mr. Thomson Henderson, is in some cases sufficient. But there are others in which something more has to be attempted. For these the following operation is suggested:

A pedicle graft taken from the cheek, slipped into the socket through a temporary opening below the lower lid and anchored to the periosteum (to prevent the new fornix from contracting up) (Fig. 5).

The first skin incision is carried along the infra-orbital margin, At each end of it a vertical cut is made so as to mark out a skin flap with its base downwards. This flap is carefully undermined and kept as thin as possible without perforating it.

The first incision is now deepened until the floor of the orbit is

reached, and the wound in the conjunctiva is planned to be so far back as to allow ample conjunctival lining for the lid.

The next step is to suture the skin flap to the posterior lip of the wound in the floor of the orbit. This is done with interrupted catgut sutures and it will be found advantageous to lay all the sutures first and to tie them afterwards.

The first stage of the operation is now complete and the graft is allowed to heal for a week or ten days.

When this period has elapsed, the vertical cuts at each end of

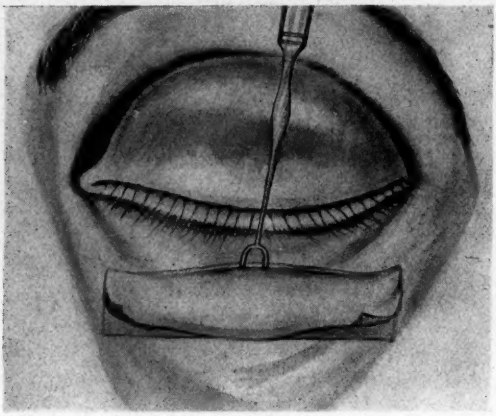

FIG. 6.

the first incision are prolonged a little downwards and their lower ends then joined together by a horizontal incision (Fig. 6). The base of the flap is now partially undermined, turned up and joined to the conjunctiva lining the lid, interrupted sutures being used as before.

It might be thought that all that now remained to be done was to close the wound on the face, and that adhesions of the flap would be sufficient to maintain the depth of the fornix. That is not so. The structures underlying the graft are all too pliable and it is necessary to anchor it to the periosteum. It is this factor in the operation more than any other which, I think, makes for success.

III.—Enlarged Socket

We are familiar with sockets in which the artificial eye is forced out by the weight of the soft tissues of the roof, and sockets which are so large that the space behind the artificial eye requires filling up with a vulcanite or gutta percha cast of the cavity. Cases of this description may be dealt with by the operation just described

but applied to the upper lid. The effect of the operation here is to fill up the cavity with a soft pad covered with skin, which forms a support for the artificial eye. The first incision (Fig. 5) is made in the principal fold between the upper lid and the loose tissue above, and the flap is marked out with a short vertical cut upwards at each end of the incision. The flap is then dissected up as before and the original incision deepened until the conjunctiva of the upper fornix is reached. Then the flap is sutured to the posterior lip of the wound in the conjunctiva. A week or ten days afterwards the base of the flap is divided, the deep structures being included in the incision. The margin of the base is then slightly undermined, and sutured to the conjunctiva lining the lid. The flap and the tissues underneath it having lost their support above owing to division of the deeper structures, sink down behind the upper lid in the course of the next week or so.

Patients who require a vulcanite support behind the artificial eye always give it up sooner or later. The reasons are, that the socket alters its shape and the eye does not maintain its original position. In addition to this it is at the best of times a troublesome device. So it is discarded and a shade is worn to hide an empty socket and a sunken lid.

The operation enables the patient to wear an artificial eye in comfort without a special support, and although ptosis results, it is easily remedied as far as the position of the lid is concerned, and the patient can move about freely without drawing particular attention to himself.

ANGIOMA OF THE CHOROID.

BY

E. ERSKINE HENDERSON,

LONDON.

THE interesting case recorded by Paton and Treacher Collins in last year's *Transactions of the Ophthalmological Society* (Vol. XXXIX, p. 157, 1919) induces me to record another case of what may turn out to be a similar condition, although the eye does not at present show any sign of coming under the pathologist.

The patient, E. H., a girl of eight, was first seen in 1917 on account of convergent strabismus of the left eye. This eye, which was considerably more hypermetropic than its fellow, had no central fixation and was quite amblyopic. The other eye had normal vision. The left side of the forehead, part of the eyelid, and temporal region were covered by a port wine naevus. The fundus at that time appeared normal. I saw her again at the beginning of 1920.

She was sent as a routine matter of school inspection, and neither the patient nor her mother had noticed any alteration in the vision of the eye since her last visit. Vision was as before, but the retina on the left side was now completely detached. It was greyish in colour and did not appear at all solid. There was no vitreous opacity and the tension was normal. Should glaucoma supervene at a later date I hope to be able to obtain the specimen for examination.

The literature of angioma of the choroid is fairly extensive, going back as far as 1879, but the number of cases in which it has been recorded as occurring in conjunction with naevus of the face are not very numerous. As it may be of assistance to others, I append a bibliography of all the cases I have been able to find up to 1915. Readers interested in the microscopical anatomy and other details of angioma of the choroid in general will find a good account and an extensive bibliography in the papers by Paton and Collins, and by Love, references to which are given.

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ANNOTATIONS

The Medical Examination of Civilian Pilots, Navigators, and Engineers

This pamphlet, issued by the Air Ministry "for the information of those, particularly in the Dominions and Colonies, who are now about to put into practice the principles laid down in the International Air Convention," is based upon the experience gained

during the war, at home and overseas, from the examination of large numbers of candidates and pilots in the Air Service, and upon that of the medical representatives of the Air Ministry who attended International Conferences in Rome and Paris. The standards decided upon by the war-time examiners were of necessity more or less arbitrary, but it speaks highly for the judgment of the medical officers concerned that on the return of the delegates from the conferences little or no alteration in these standards was immediately necessary.

An extract from the "Convention relating to International Air Navigation, 1919," contains the medical requirements agreed upon at the convention. It gives, in clearly and succinctly expressed general terms, the conditions which will render candidates eligible or ineligible, with a final paragraph stating that "each contracting state may raise the conditions set forth as it deems fit, but these minimal requirements shall be maintained internationally."

In the introductory paragraphs the Air Ministry, with a broad mindedness all too uncommon in government documents, say that "although great advances have been made towards accurate estimation of efficiency (of candidates) both mental and physical, this science is still in its infancy, and therefore it is undesirable to lay down hard and fast standards. Indeed, it is the object of these notes, while acting as a general guide, to leave the final word to medical judgment and common sense."

Of the sections dealing with the medical examination of candidates that on "eye examination" is of chief interest to our readers. It contains directions for the employment of tests for vision, colour vision, heterophoria, convergence power, and fields of vision. Considered as an outline of instructions they may escape criticism, especially as it is stated that "doubtful cases should be referred for examination by a specialist."

Although the standard of visual acuity required is stated to be 6/6 with each eye, the Air Ministry express the opinion which will probably be generally endorsed, that in certain suitable cases this standard may be relaxed for civilian aviators, but that it should not be below 6/9 and 6/12, "correctable" to 6/6 with glasses.

Normal colour vision is, of course, deemed essential. The "apparatus required" for examination for defective colour vision is the Board of Trade test lamp.

Bloom v. Cawley

The facts of a case recently decided in the Manchester City Police Court deserve to be widely known. The parties concerned were Maurice Bart Bloom, managing director of Messrs. Bloom's,

Limited, opticians, of London, Liverpool, Manchester, and elsewhere, and a Mr. John Cawley, of Didsbury, who ordered on December 6, 1919, from Bloom's local branch, a pair of bifocal spherical spectacles for six guineas, sight testing free. Mr. Cawley, thinking the price charged excessive, secured quotations elsewhere, and found that the average cost of glasses as supplied by Bloom's, Limited, to him was £4. He placed the matter before the local profiteering committee, which ordered a refund of £2 6s. and directed a prosecution. Bloom's, Limited, appealed against the decision, but the appeal was dismissed by the Tribunal, and the prosecution took place. In the upshot the defendant was fined £50 and £25 costs. It was brought out in evidence that although styling themselves "eyesight specialists," the folk who ran the Manchester branch of the business were all quite without qualification as opticians, the only qualification they might be said to possess was that of being able to sell spectacles. The manager of the Liverpool branch, who was called, had to admit that the "most enlightened and complete optical service ever known in this old country," was conducted by three girls, one lad, and himself, and he was unqualified from an optical point of view. It was brought out in Court that the glasses supplied by Bloom's, Limited, to Mr. Cawley were of very defective workmanship—the edging of one lens showed two gaps, and the other lens was decentered 5 mm. down and out, producing the effect of a prism. One expert witness, indeed, stated that he had "never seen such a badly made pair of Kryptok spectacles."

ABSTRACTS

I.—METHODS OF MEASURING HETEROPHORIA

(1) **Weymouth, Frank W. (Leland Stanford Junior University.) An experimental comparison of three common methods of measuring heterophoria.** *Ophthalmic Record*, June 1916.

(1) **Weymouth** made a comparison of the results obtained in measuring the heterophoria, at a distance of 7 metres, of twelve persons by the von Graefe test, the Maddox rod, and by a modification of the parallax test. The results show that, when conducted with certain precautions, all the methods give accurate and consistent measurements which differ so little as to make the choice of method a matter of indifference. In the matter of variability the von Graefe test showed a small but constant

superiority. The von Graefe and the Maddox rod gave practically the same degree of heterophoria, but the parallax test showed about 1 prism diopter more exophoria.

The most important precaution to be observed is the use of a dark-room, particularly with the von Graefe test or with the Stevens phorometer; lacking the dark room the test object should be placed against a large unfigured wall or screen.

The ordinary tests may be improved or checked by alternately covering the eyes occasionally during the observation as suggested by Duane. The variation from day to day will usually greatly exceed the variation between the results of the various methods and a reliable picture of the muscular condition can only be obtained by several observations under varying conditions.

J. JAMESON EVANS.

(2) **Dolman, Captain Percival (Mineola, Long Island, N. Y.). Maddox Rod Screen Test.** *Trans. Amer. Ophthal.* Soc., Vol. XVII (1919), p. 235.

(2) It is generally recognized that the safety of the aviator depends more upon good muscular balance than upon good visual acuity. Under the stress of flying, the aviator with a hyperphoria or a divergence excess is apt to have the error become manifest as a diplopia, which would make a safe landing nearly impossible. Hence the importance of examining the extraocular muscles in the air service, in order to discover any defect which might jeopardize the life of the aviator. Several tests for the detection of heterophoria were approved by the Ophthalmological Department of the American Medical Research Laboratory at Mineola, New York, but all of these were finally eliminated in favour of the Maddox rod, the screen, and the parallax tests. On account of its simplicity the Maddox rod test led to the partial exclusion of the others named. But questions arose as to the accuracy of the test in question, as, for example: (*a*) some aviators were unable to see the light and the line at the same time; (*b*) others complained of the line moving about so erratically that measurements could not be taken; and (c) still others showed a tendency to fuse the line with the light, thus indicating orthophoria when some form of heterophoria was known to be the condition. In civil life many criticisms have been levelled against the test—that it is apt to indicate an excess of esophoria (Duane, Weymouth); that some patients show a tendency to fuse the line with the light (Duane, Stevens); that certain patients have experienced difficulty in seeing the line of light (Weymouth), and so forth. Dolman has now investigated the alleged defects of the rod, mainly upon aviators, the screen and the parallax tests being used as controls. The apparatus used was a De Zeng

phorometer trial frame equipped with a pair of Maddox rods and a pair of Risley rotary prisms. The spot of light was obtained from a frosted Mazda lamp surrounded by an opaque chimney, perforated by an iris diaphragm. The tests were made with the eyes in the primary position, looking at the light twenty feet away.

The criticisms directed against the Maddox rod are grouped under the following four heads:

I. *Excessive esophoria.*—100 men were examined, and an analysis of the results showed that 72 of them had ½ to 2 prism diopters more esophoria or less exophoria by the Maddox rod than by the control tests. The various factors entering into the test were eliminated by experiment until two remained: A. latent hypermetropia, and B. false projection of the line. A. Emmetropes free from heterophoria were rendered artificially hypermetropic by placing a 1.D. concave lens before one eye, and then the Maddox rod was placed before the other eye. The test at once registered esophoria, which changed to orthophoria on removing the concave lens. Dolman calls attention to the fact that those with unequal, uncorrected hypermetropia usually employ the eye with the smaller refractive error for the purpose of clearest vision. If the eye be covered with the Maddox rod, the result of the test will be based upon the greater amount of hypermetropia in the light fixing eye, and such a finding will show more esophoria than actually exists. Hence a patient should wear his refraction correction during the test for heterophoria. B. *False projection of the line.*—Most patients say they see the line of light nearer than the source of light—that is, 20 feet away. Some see the line a few inches from the face, but the majority project it from 3 to 10 feet away. A special effort is therefore made to focus the eye for that distance, so that the accommodative effort brought into play produces a convergence which in turn increases the amount of esophoria. If the line is seen indistinctly, false projection is more apt to occur. The obvious precaution against false projection is to keep the observer's attention fixed upon the light as continuously as possible during the test.

II. *Fusion Tendency.*—Dolman's experiments have shown that the fusion tendency is increased by certain conditions that may occur in the Maddox rod test. They include: A. The exclusion of extraneous retinal images. B. Horizontal and vertical lines in the background. C. Additional sources of light. D. The intensity of the spot of light. A. When the room in which the test is being made is darkened completely, the fusion tendency is very strong. On the other hand, when the room is not darkened the fusion tendency is decreased. B. The line of light fuses readily with horizontal and vertical lines situated near the point of light, as the vertical lines of door and window casings, cabinet edges, etc. The vertical

standard made particularly to support the lamp used in the experimental tests acted in this way and escaped notice for several months. C. The spot of light arranged for the purpose of the test should be the only source of illumination visible to the observer. D. When the spot of light is very brilliant, an intensely bright line is formed and the fusion tendency is greatly increased. A spot of light of very moderate intensity is sufficient for the purposes of the test in a semi-darkened room.

III. *Instability of the line.*—The line is frequently observed to lack stability, or, as patients say, it "wavers" or "dances." Experimental studies demonstrated that the movement was checked when the observer concentrated his attention and fixation on the light, and at the same time disregarded as much as possible the image of the line, and similarly the movement was checked when the line was fixed and the image of the light disregarded. From those facts it follows that movement of the line may result from an effort to fix both the line and the light at the same time or as a result of fixation which alternates between the light and the line. In simultaneous fixation the movement may be due to—(a) the fusion tendency. In alternating fixation it may be due to—(b) unequal hypermetropia; (c) false projection of the line.

IV. *Inability to see the line.*—The causes may be grouped as follows: (1) malposition of the Maddox rod; (2) bright illumination of the room; (3) dimness of the spot of light; (4) non-essential sources of light; (5) poor vision in one eye; (6) habitual suppression of one image; (7) poor vision in both eyes.

The author then describes the Maddox Rod Screen test, which has been adopted by the Medical Research Laboratory as giving accurate results, although he claims no originality for the general idea. The patient is seated facing the light, arranged at the height of his eyes and at six metres distance from the last-named. The Maddox rod may be held in position by a trial frame and the measurements made with square prisms or with those found in the trial case. The test is much simplified by the use of a modern phorometer trial frame, equipped with a double multiple Maddox rod and a double Risley rotary prism. This apparatus is fixed close to the patient's eyes and adjusted to a horizontal position by means of a spirit level. Both the rod and the prism are swung into position before one eye. A card-screen (about 6 cm. by 9 cm.) is moved from one eye to the other a few times to ascertain if the patient sees both the line and the light, and if the line is not seen readily the rod is readjusted by centering it carefully, or some further darkening of the room may be necessary. When the patient sees both line and light easily, the test is begun by holding the screen in front of the rod, so as to shut out the image of the line. After he has fixed the

light for several seconds the screen is removed for an instant and quickly replaced. In the brief interval the patient should be able to see the line and to locate it with reference to the light. After one or two brief exposures he will be able to say in a test for lateral imbalance that the line is to the right or left of the light or possibly through it. He is next told to turn the milled head that rotates the prism and to bring the line directly through the light. To enable him to do this, the screen is removed from the eye at intervals and quickly replaced. The measuring prism is always placed before the eye that is covered by the Maddox rod.

Dolman's conclusions are as under:

1. The Maddox rod test, because of its easy application and the simple nature of the observation required, enjoys a popularity and wide-spread use among ophthalmologists.

2. Studies of heterophoria, based wholly or in part on Maddox rod findings, are constantly being reported in ophthalmic literature in spite of some serious criticisms of the test.

3. The test has been condemned chiefly because it shows excessive esophoria, a tendency to fusion, and an instability of the line of light.

4. These faults of the test have been verified and the underlying causes studied.

5. The Maddox Rod Screen Test, a simple modification of the usual procedure, gives results that are accurate and free from the above criticisms.

S. S.

II.—KERATITIS DUE TO MELINITE

Perrin, Robert (of the French Army.)—A study of a form of keratitis due to melinite. (Etude de la kératite due à la mélinite (avec presentation du malade). *La Clin. Ophtal.*, September, 1919.

Perrin appears to have discovered a new type of diffuse sub-epithelial keratitis due to the fumes of melinite. The patients, 32 in number, were all soldiers engaged in filling shells with melted melinite. They all presented practically the same appearances of the cornea and the same symptoms, and they all were completely cured in from six to nine weeks. In the case of a first attack this does not come on until at least eight months' exposure to the fumes, though, in the case of relapses due to going back to the work, a fresh attack may come on after one month.

The following is the description of the condition, slightly abbreviated:

The appearance of the cornea is characteristic. It is infiltrated, and the greatest infiltration is at the central and lower portion. This infiltration is "milky." It appears as a small, localized, rather thick cloud, as if one had dusted (*saupoudré*) this part of the cornea. The infiltration takes a triangular form, the apex of the triangle at the limbus. There is no pericorneal reaction and no abnormal vascularisation. In fact there are none of the phenomena accompanying acute and subacute keratitis. There is no pain, only a little pricking and itching. The affection is bilateral. No other part of the eye is affected. Subjectively, the patient has foggy vision, and can hardly find his way about. The V.A. (of the actual patient shown) is R.E. 1/20, L.E. 1/16.

The visual field is normal; central vision is worse than peripheral. No dyschromatopsia. But a phenomenon characteristic of all the cases is the appearance of a halo around lights. This halo is in three colours, green, yellow, and red, from the centre outwards; a regular rainbow in fact. Bacteriological examination is entirely negative. The treatment has consisted in the application of yellow oxide ointment, methylene blue lotion, and bathings with borate of soda. Cure is complete in about six weeks. Absolutely nothing remains of the affection. The principal treatment, however, is the removal of the patient from the fumes of the melinite.

The author states that he has only given a summary of the affection. It remains to be determined, especially, what exactly is the harmful chemical element in the vapour from melinite which gives rise to the keratitis.

ERNEST THOMSON.

III.—ORGANIC MUSCLE FIBRES IN THE CHOROID

Fuchs, Ernst (Wien).—Organic muscle fibres in the choroid. (Ueber organische Muskelfasern in der Aderhaut.) *Archiv f. Ophthal.*, Vol. XCV, Part IV, 1918.

The offshoots of the ciliary muscle lie in the anterior part of the choroid immediately adjoining the ciliary body, but it is a debated question whether muscle fibres are present in other portions of this layer. According to some writers they occur in the long posterior ciliary arteries or in the innermost vascular layer, while others have failed to find them in the posterior parts of the eye. **Fuchs** found muscle fibres in the choroid in the neighbourhood of the papilla in frontal sections through the optic disc. He was unable to observe them in sections made parallel to the surface from preparations obtained by separating the choroid into its various layers, or in the

usual cross sections of the choroid, owing perhaps to the fact that they are flattened in keeping with the plane of the choroid, and hence in transverse sections are too thin to be recognized as muscle fibres with certainty, and also because they may be hidden by the chromatophores. He is therefore compelled to leave it an open question, whether muscle fibres regularly occur in the choroid or not.

Fuchs describes the appearance of these fibres, which are recognizable by their shapes and staining properties, their tendency to break up at their ends into a brush of very fine fibrils; an illustration in the text shows their course as single fibres or arrangement in bands or fine meshworks.

In their behaviour to staining reagents they resemble the muscle fibres of the posterior ciliary arteries.

As regards their situation, they lie for the most part in the suprachoroidea or slightly in front of it, between the arteries in the outermost layer of the choroid, and only exceptionally between these arteries and the veins.

As to function, the muscle fibres may perhaps serve to give the choroid a certain tone, which it would be necessary to assume if, as Straub asserted, this layer has to bear a part of the intraocular pressure.

THOMAS SNOWBALL.

IV.—ARTERIAL BLOOD PRESSURE IN THE RETINA

(1) **Duverger, C. and Barré, J. A. (Strasbourg).—Arterial blood pressure in the retina. (Tension artérielle rétinienne.)** *Arch. d'Ophtal.*, February, 1920, p. 71.

(2) **Velter, E.—Some measurements of arterial blood pressure in the retina. (Quelques mensurations de la tension artérielle rétinienne.)** *The same*, p. 88.

The authors of these papers followed Bailliart's method[1] of measuring retinal arterial blood pressure; their results do not entirely agree with his.

(1) **Duverger** and **Barré** examined 56 hospital patients, proceeding as follows: Homatropin, and half an hour later cocain, having been used to the eye, (1) the tension was taken with the Schiötz tonometer. (2) In a dark room, the Thorner ophthalmoscope was focussed on the eye so as to give a highly magnified picture of the vessels of the papilla. Bailliart's dynamometer was

[1] See *Brit. Jour. of Ophthal.*, 1918, p. 487.

applied directly over the external rectus with gradually increasing pressure until pulsation of the artery appeared, and the pressure at that moment was noted. The pressure was then increased until pulsation disappeared through persistent closure of the artery, and its amount was again noted. (3) The patient having returned to the couch, these pressures were reproduced by re-applying the dynamometer, and at the same time the intraocular pressures associated with them were measured by means of the tonometer. These latter represented the diastolic and systolic pressures in the artery. In each case an independent observer, who knew nothing of these results, measured the brachial blood-pressure by means of an apparatus acting on the Marey-Pachon principle for the minimum pressure, on the Riva-Rocci for the maximum. In comparing the brachial with the retinal blood-pressure an amount of 20 mm. Hg. was always subtracted from the former to eliminate the difference caused by difference of level.

The artery was considered to pulsate only when it was seen to empty and fill, i.e., to become white and red alternately; minor pulsation, such as, doubtless, occurs in the retinal as in other small arteries, but which is invisible or only revealed by a change in the light reflex, was disregarded. Thus, to simplify the question, the authors say: When the arterial pressure is greater than the intraocular, the artery remains fixed; when it is less the vessel empties; when it is alternately greater and less, it pulsates.

The authors declare the proceeding to be complicated, exacting much docility in the patient, sometimes impracticable for that reason, sometimes painful, and, perhaps, not always free from risk of injury. They lay stress on certain obvious sources of uncertainty which need not be detailed here. One such, and, perhaps, an important one, they do not mention—the doubtful value of the mercury-equivalents ascribed to the Schiötz tonometer.

Despite these uncertainties their numerous measurements are so far in agreement among themselves as to lead with apparent reason to the following conclusions:

1. The normal blood pressures in the human eye are on the average: minimum (diastolic) 50—60 mm. Hg.; maximum (systolic) 80—100 mm. Hg.

2. Excess of pressure of long duration in the retinal artery does not augment the intraocular pressure.

3. Excess of intraocular pressure does not augment the pressure in the retinal artery.

4. The pressure in the retinal artery, apart from the difference due to vertical elevation, appears to be equal to that in the brachial; in any case its variations are parallel with those of the general arterial pressure. There is no such thing as a local retinal pressure different from the general pressure.

5. If these results are verified we shall be able to estimate the arterial pressure in the retinal artery with sufficient accuracy by measuring that in the brachial—making allowance for the difference of level.

A case of non-congestive glaucoma is given in detail, with charts showing maximum and minimum arterial pressures in retina and arm, with the associated intraocular pressures found at intervals over a period of 14 days. Between the blood pressures in the two regions there was on the whole a pretty close correspondence, while between these and the intraocular pressures there was a decided want of correspondence. Moreover the patient's two eyes had nearly equal arterial pressures at the times when their intraocular pressures differed widely—a highly significant observation.

(2) **Velter's** results agree pretty closely with those just cited, except that he found lower averages for the normal retinal diastolic and systolic pressures, viz., 35 and 65 mm. Hg. respectively—a difference which he thinks was perhaps due to his not having a Thorner apparatus at disposal. He accepts the Bailliart principle as good, but lays stress on the difficulties and uncertainties attending it.

He, too, found fairly close parallelism, though not equality, between the arterial pressures in retina and arm, the retinal being the lower of the two—allowance being always made for difference of level. On the other hand, he found no evidence that increase of intraocular pressure augments retinal arterial pressure. If such augmentation occurs, he says, it is minimal, being smaller in amount than the errors of measurement which are inevitable, especially in hard eyes requiring high pressure of the dynamometer. If it occurs, moreover, it is explicable in a purely physical way, and does not justify any assumption of a hypothetical pressure-regulation centre. In his series of cases showing measurements of fellow eyes having different intraocular pressures, some *do* show a higher arterial pressure in the harder eye, but others do not.

Not as contradicting these interesting observations, but as tending to modify the inferences to be drawn from them, two indisputable principles should be borne in mind: (1) When an artery is gradually compressed, whether by a finger, by an airbag, or by a dynamometer in the manner of Bailliart, the blood-pressure above the compressed part rises, and when the artery closes the pressure above the closed part is higher than it was when the blood was moving. The amount of the excess varies with several separate factors (see *Brit. Jour. Ophthal.*, Vol. I, p. 658). Measuring in this way, we measure the pressure of the arrested blood-column, not the pre-existing pressure, and the same is true of a manometer tied into a severed artery. (2) A rise or fall of pressure in the afferent arteries of the eyeball, unless it is counteracted by

some other change, induces a similar but much smaller change of pressure in the chambers (see, for example, the observations of Foster Moore on human eyes).[2] But if their conclusions are, perhaps, rather too rigid, the authors certainly give us fresh proof that high intraocular pressure does not commonly depend on high blood pressure.

PRIESTLEY SMITH.

V.—THE PROGNOSIS OF THE ARGYLL ROBERTSON SIGN

Rasquin, E. (Namur), and Dujardin, B. (Brussels).—The prognosis of the Argyll Robertson sign. (Le pronostic du signe d'Argyll Robertson.) *Arch. Med. belges*, Jan., 1919.

Rasquin and **Dujardin** believe that the Argyll Robertson pupil does not occur without a syphilitic taint. They have found the characteristic reaction in many cases in which there was no other clinical sign of syphilis or post-syphilitic disease of the nervous system.

The ophthalmic surgeon may meet with cases of Argyll Robertson pupil in the course of routine examination when no complaint of any symptom is present; it is, therefore, of considerable importance that he should be able to recognize its precise significance. The authors recommend that in all such cases the following tests should be made: 1. Bordet-Wassermann blood test. Quantitative estimate of the intensity of this. 2. Reactivation in cases in which Bordet-Wassermann was negative. 3. Lumbar puncture with examination of the cerebro-spinal fluid as regards tension, lymphocytosis, quantity of albumen, nature of globulins, Bordet-Wassermann test. 4. As an accessory the luetin test. Considerable importance is to be attached to the permeability of the meninges for syphilitic anti-bodies since this is in direct relation with the degree of inflammation and serves to measure the importance of the meningeal inflammation which is responsible for most of the nervous syphilitic diseases. The degree of permeability is readily ascertained by comparing the concentration of anti-bodies in the cerebro-spinal fluid and in the blood. The authors examined 85 cases of Argyll Robertson pupil which exhibited no other symptom of syphilis. They were able to divide these into three main groups: 1. With meningeal reaction (Babinski's syndrome). 2. Without meningeal reaction, but with positive Bordet-Wassermann blood reaction. 3. Without meningeal reaction and with

[2] *Roy. Lond. Ophth. Hosp. Reports*, Vol. XX, p. 108, 1915, and abstract in *Ophthalmic Review*, Vol. XXXIV, p. 245, 1915.

negative Bordet-Wassermann blood test. They further sub-divide group 1 into those in which Wassermann is positive in blood and cerebro-spinal fluid, is negative in both, and is positive in one only. In group 3 they differentiate those cases in which reactivation produces a positive blood reaction and those in which it fails to do so. Naturally the prognosis as regards serious progressive nervous disease is worst in the first group and may be considered quite good in the third group, while those in group two occupy an intermediate position. Several illustrative cases are quoted in the paper.

E. E. H.

VI.—EYE AFFECTIONS OF LETHARGIC ENCEPHALITIS

(1) **Woods, Hiram (Baltimore, Md.).—Some cases of lethargic encephalitis.** *Trans. Amer. Ophthal. Soc.*, Vol. VIII (1919), p. 306, and *La Clin. Ophthal.*, January, 1920.

(1) As **Woods** is under the impression that heretofore the eye manifestations of lethargic encephalitis have not been made the subject of special study, he reports at length six cases that came under his notice during the months of February, March, April, and May, 1919. It is impossible to go into the details of these cases, but we give the author's summary as follows: "A peculiar disease, termed lethargic encephalitis, has been appearing sporadically throughout Europe during the last six months. The disease is characterized by an insidious onset, lack of symptoms of an infectious nature, stupor, and involvement, sometimes paralysis, of various muscles, but chiefly the muscles of the eye or face. The ocular symptoms consist of either relative or total paralysis of the intrinsic or extrinsic muscles, ptosis, and nystagmoid movements. One or several of these symptoms may be present. The ocular symptoms have a definite tendency toward spontaneous recovery." How far Woods's statement made early in the course of the communication (page 306) that "the disease appeared first during the winter of 1916-17 in Vienna" is correct may be judged from the abstract of Dor's article given below.

S. S.

(2) **Dor, L. (Lyon). — The eye affections of lethargic encephalitis. (Les troubles oculaires de l'encéphalite léthargique.)** *La Clin. Ophtal.*, January, 1920.

(2) **Dor's** short article is worthy of close attention. "The disease, improperly called lethargic encephalitis and which is

nothing else than a mesencephalitis with narcolepsia as designated by J. L'Hermite and St. Martin, presents ocular affections which are almost constant, and may even develop with eye affections alone without narcolepsia or with actual insomnia. Ophthalmologists should be well informed about this disease, which is by no means new. Gaget described a case accurately in 1875. Wernicke called it acute haemorrhagic superior polioencephalitis. It was called *nona* by the Italians in 1889, while Gillet de Grandmont recorded a case in 1890."

The pathogenic agent is unknown but it is clear that the disease is transmitted, like cerebro-spinal meningitis, by rhino-pharyngeal secretions. Like meningococcia (*meningococcie*) lethargic encephalitis is a paragrippal disease and some day it will be called somnococcia, when its parasite has been isolated and called the somnococcus. This expression will be a more exact one since, while the patients sleep often, it is quite the exception for them to be lethargic. The disease must not be designated sleeping sickness for this would confuse it with trypanosomiasis due to the tsetse fly.

The most striking fact as regards the ocular affections is the bilaterality of the muscular paralyses. The author has recently come across three cases with convergence and satisfied himself that this was due not to double paralysis of the external recti, but to paralysis of divergence. He gives his reasons based on the usual tests of eye movements and the study of the diplopia. "These lines are written," says the author, "in order to put ophthalmologists on their guard against the temptation to make a diagnosis of paralysis of both external recti in cases in which the paralysis is really of divergence function." The distinction is of importance, since autopsies may thus result in the discovery of the centre for divergence. It is of importance also in the matter of the nomenclature of the disease, since it shows that the disease cannot be, as has been said, a polioencephalitis, but is indeed a diffuse mesencephalitis. "All cases of bilateral ptosis, of paralysis of accommodation, and of diplopia coming on suddenly and accompanied by slight fever, should be followed out with interest and the patients questioned regarding their sleep. One will, in this way, discover doubtful cases (*cas frustes*) and will find out whether ophthalmoplegia without narcolepsia is here more or less frequent than narcolepsia without ophthalmoplegia."

ERNEST THOMSON.

VII.—BLOOD EFFUSION INTO THE CORNEA

Pisarello, Carlo.—Blood effusion into the cornea. (Apoplessia della cornea.) *Arch. di Ottal.*, June-July-Aug., 1918.

Pisarello reports three cases of this uncommon condition.

The first was that of a child of 9 years of age who had received a blow from the corner of a towel. Pain did not come on for a few hours. She was not seen by Pisarello till nine days later. He was then unable to find any trace of a wound. The left eye was intensely injected, slightly proptosed and stone hard. The corneal sensibility was diminished, the anterior chamber was filled with blood and there was also intralamellar haemorrhage into the cornea. Paracentesis repeated twice on the two following days was followed by the exit of a large quantity of blood, partly fresh. Two days later the tension fell and the cornea began to show a green colouration. At a later period when the cornea had become transparent near the edge, considerable damage to the interior of the eye could be made out. Cyclodialysis was present over a large area of the root of the iris. Ten months later a central disc of opacity was still present and the iris was atrophic. Vision was 1/10.

The second case was that of a man, aged 17 years, who had injured the eye by a blow with a nail causing a wound running vertically from the centre of the cornea to a point 3 mm. beyond the limbus. The anterior chamber was full of blood and there was a small prolapse of the iris. The removal of the prolapse caused a considerable fresh effusion of blood into the anterior chamber. The eye was stone hard on the following day and no improvement followed two paracenteses, as fresh haemorrhages always followed the operation. Two days later the tension fell and a central disc of haemorrhage into the cornea became defined. Six months later the central opacity was still well defined and the vision was only light perception. The opacity and the scar prevented any ophthalmoscopic examination.

The third case was that of a soldier injured by a mine explosion. The eye had an extensive wound in which a piece of stone was lying. Ten days later the cornea was invaded by an extravasation of blood with the characteristic green colour, the resorption of the extravasation began in the usual way from the periphery and had advanced so far as to leave a transparent ring at the end of a fortnight. The eye was soft all the time and, as there was now no perception of light, excision was advised. This the patient refused and was subsequently lost sight of on his discharge to a reserve hospital.

Pisarello gives a good bibliography and a review of the various theories that have been advanced to account for the condition.

He advances no new one, but considers that no one theory will account for all the cases, but that there is some truth in all the suggestions. His pathological views are in accordance with those expressed by Treacher Collins at the Ophthalmological Society.

E. E. H.

CORRESPONDENCE

CENTRALBLATT F. PRAK. AUGENHEILKUNDE

To the Editor of the BRITISH JOURNAL OF OPHTHALMOLOGY.

SIR,—When the war broke out Professor Hirschberg, of Berlin, at once removed my name and the names of his other enemy collaborators from the *Centralblatt für praktische Augenheilkunde.* At the same time he printed a note regarding the terrible war which its enemies had wickedly brought upon the Vaterland; a note which drew a very forcible rejoinder from Dr. Darier, of Paris, in *La Clinique Ophtalmologique.* The matter ended there, satisfactorily, as far as I was concerned.

You may imagine my surprise and annoyance to find, on returning to England after eight years absence, and once more seeing copies of the *Centralblatt,* to find that my name has been printed on its title page, without my consent, since 1915. I have written and requested Professor Hirschberg at once to remove it, and think I may in fairness ask you kindly to print this letter in explanation of my apparent connection with this Journal during four years of war.

Yours etc.,
F. P. MAYNARD,
Lt.-Col., I.M.S. (Retd.)

CREWE,
July, 1920.

ONE-EYED MOTOR DRIVERS

To the Editor of the BRITISH JOURNAL OF OPHTHALMOLOGY.

SIR,—The Committee who drew up the report on vision for motor drivers, found considerable difficulty in obtaining evidence of the danger of men who had lost one eye driving motor vehicles.

The following instance, first hand, is direct evidence:

Whilst motoring I was stopped on the road to find a man had been thrown off his motor bicycle and was evidently suffering from a cut head, fractured base, and several other injuries. The man had a glass eye on the right side. As far as I could tell from the history of the accident, he was passing between a cart

going in the same direction and a motor car passing him in the opposite direction. Apparently his right handle bar had hit the car on the spare tyre which the man was carrying beside the driving seat in the ordinary way for it carried away the hooter on the right handle bar of the bicycle. Evidently the motor cyclist had misjudged his distance from the car owing to the fact that he was blind on the right side.

Yours truly,

M. S. MAYOU.

HARLEY STREET, W.
June, 1920.

BOOK NOTICES

The Extra Pharmacopoeia. Vol. I. 17th edition. By W. H. MARTINDALE and W. W. WESTCOTT. Pp. 1115. Fcap 8vo, Price 27s net. H. K. Lewis & Co., Ltd., 136, Gower Street, W.C1. 1920.

That useful, nay indispensable compendium, the Extra Pharmacopoeia, has now reached its seventeenth edition, and under these circumstances nothing need be said as to its well-deserved popularity. The latest ophthalmic products receive adequate mention. It opens with a most patriotic preface, which is worth reading for its own sake.

S. S.

Transactions of the American Ophthalmological Society, 1919. Philadelphia: published by the Society. T. B. HOLLOWAY, *Secretary.*

This attractive-looking volume of 741 pages, illustrated and carefully indexed, contains an account of the Society's fifty-fifth annual meeting held at Atlantic City in June, 1819. The large size of the book is largely accounted for by the fact that it includes the theses, some of which are rather long, of candidates for admission to the Society. It begins with an account of R. A. Reeve, who died on January 22, 1919, and appended is a speaking portrait of our esteemed colleague. Many of the papers it contains will be noticed in abstract form in our columns.

S. S.

The Ophthalmic Year Book. March, 1920. Vol. 16. Part I. Published quarterly by the Ophthalmic Publishing Company, 318, Majestic Building, Denver, Colorado. Annual subscription, ten dollars in advance.

As readers will doubtless recall, the *Ophthalmic Year Book* maintained for thirteen years a separate existence, at the end of which time it was absorbed by the *American Journal of Ophthalmology*, and appeared as an integral part of that Journal. It now reaches us as a separate quarterly periodical, stated on its cover as

"formerly supplement to the *American Journal of Ophthalmology*," while on an inside sheet we are told that "it continues to be issued as a supplement to the *American Journal of Ophthalmology*." We can only reconcile these apparently conflicting statements by assuming that the word "supplement" is employed in two different senses in the sentences quoted. The retention of the title, *Ophthalmic Year Book*, for a three-monthly publication has advantages, and may indeed be justified when it is understood that each part reviews the literature of the topics with which it deals for one year.

As far as its contents are concerned, they reach as high a standard as they did in former years, and that is equivalent to saying a great deal.

S. S.

Wright's Medical Annual, 1920. London: SIMPKIN, MARSHALL, HAMILTON, KENT AND CO. Price 15s. net.

This excellent volume, now in its thirty-eighth year, still maintains its high standard of excellence. It deals with all the recent additions to medicine which are of any interest. The ophthalmic section which used to be edited by A. H. Thompson is now edited by R. Foster Moore. The reviews of the recent additions to Ophthalmology are excellent. The articles on diseases of the cornea and tumours of the orbit are worthy of particular note. All the articles ought to be extremely useful for the medical man who is unable to obtain the original articles.

M. S. M.

NOTES

Deaths

THE deaths are announced of two American ophthalmic surgeons, namely, C. P. Linhart, of Columbus, Ohio, and P. Marshall, of Warren, Ohio.

* * * *

Appointments

B. T. LANG has been appointed assistant surgeon to the Royal London Ophthalmic Hospital.

Emilio F. Montano has been appointed to the chair of ophthalmology in the University of Mexico, in succession to M. Uribe Troncoso. Daniel M. Velez has received the professorship of ophthalmology in the School of Advanced Studies, a department of the University of Mexico.

Pesme has been nominated chief of the ophthalmological clinic in the University of Bordeaux.

Artificial Eyes

WE gather from an announcement made by the Ministry of Pensions that those men who have suffered the loss of an eye in war service can obtain an artificial eye from the Optical Appliances Dépôt, Clifford's Inn, London. Applications should be made in the first instance by injured men to the Local War Pensions Committee.

* * * *

Council of British Ophthalmologists 1920-1921

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Sir Anderson Critchett, Bt., K.C.V.O., Sir George Berry, Sir John Tweedy, Mr. Priestley Smith, Mr. Richardson Cross, Mr. W. Lang, Mr. J. B. Lawford, Mr. E. Treacher Collins, Mr. W. T. Holmes Spicer, Mr. J. B. Story, Mr. Sydney Stephenson, Mr. J. Herbert Fisher, Dr. Jas. Taylor, C.B.E.

Elected Members by the Ophthalmological Society of the United Kingdom:
Mr. J. Herbert Parsons, C.B.E., Mr. Stephen Mayou, Mr. A. Bernard Cridland, Mr. A. L. Whitehead,

By the Section of Ophthalmology of the Royal Society of Medicine:
Dr. George Mackay, Mr. W. G. Laws, Mr. Leslie Paton, Mr. A. W. Ormond, C.B.E.

By the Oxford Ophthalmological Congress:
Mr. P. H. Adams, Mr. E. H. E. Stack.

Officers for 1920-1921:

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Treasurer: Mr. J. Herbert Fisher.

Secretary: Mr. Leslie Paton.

Executive Committee: The President and Secretary with Messrs. Collins, Fisher, Parsons, and Mayou.

* * * *

Errata

TWO errors crept into Dr. H. Hartridge's article on "Colour Blindness and Young's Hypothesis," published in the last number of the *British Journal of Ophthalmology*. On page 320, twenty-three lines from the top, for the words "wave length" read "spectral point"; in the reference given on page 322 (4) for "Scheming" substitute "Tscherning." Dr. Hartridge's corrected proofs were posted in Cambridge on June 18, but, for reasons as yet unexplained, did not reach the offices of this Journal until July 1, at a time, that is to say, when the Journal was already in the hands of subscribers. We have taken up the matter with the postal authorities.